

## The Extent of Drilling in Lateral Approaches to the Cranio-Cervical Junction Area from a Series of 125 Cases

G. Lot and B. George

Department of Neurosurgery, Lariboisière Hospital, Paris, France

### Summary

The trans-condylar approach to the craniocervical junction area (CCJA) requires a more or less extensive drilling of the two first cervical joints (C0–C1 and C1–C2). The extent of drilling necessary to resect a lesion at the CCJA was analyzed from a series of 125 cases including 114 tumours and 11 non-tumoural processes treated using a lateral approach (postero-lateral or antero-lateral) over a 15-year period (1980–1995)

The extent of drilling was estimated on CT scanner axial views from the reduction of the joints surface and three groups were determined: A/less than one third B/between one third and one half, and C/more than one half. The extent of drilling was compared with the lesion location in relation to the bone limits of the CCJA: within these limits, outside them and into the bony structures. It was also analyzed with regard to pathology when separated into three groups: non-osseous tumours, osseous tumours and chordomas, and non-tumoural processes.

Only 26 cases had a significant drilling, i.e. more than one third of the joint surfaces and of these, 14 were more than one half. In all these 14 cases, the bone structures were already invaded and 13 of them were, to some extent, beyond the bone limits of the CCJA. Of the 12 cases with drilling between one third and one half, 11 involved the bone structures and 1 was located inside the CCJA bone limits. Drilling of more than one third was required only in the case of bone lesions: 10 out of 23 bone tumours, all the 14 cases of chordomas, one case of rheumatoid arthritis and one case of C1–C2 joint spondylosis. In the other cases including mostly non-osseous tumours, drilling was limited to less than one third, though a high rate of complete removal was achieved (98%). Stabilization by arthrodesis with posterior grafting (N = 10) or by lateral bone grafting (N = 5) was achieved in all cases involving more than one half drilling, and in one case of tuberculosis.

By adequately choosing the surgical approach, the extent of drilling can always be minimal. Extensive bone resection is only necessary when the tumour has already destroyed the joints. In that case, lateral or posterior fusion is an efficient technique.

**Keywords:** Cranio-cervical junction; foramen magnum; lateral approaches; occipital condyle.

### Introduction

Interest has recently been directed towards the cranio-cervical junction area (CCJA) using the lateral

approaches. Different names have been given to these lateral approaches: far lateral, extreme lateral and trans-condylar approach [1, 2, 4, 9–14]. This last name indicates precisely the principle of these approaches which is to go through the occipital condyle to reach the antero-lateral part of the CCJA. However, in our experience of 125 lesions in and around the CCJA surgically treated by a lateral approach, it was never necessary to drill the condyle unless it was already invaded by the pathological process. The purpose of this paper is to define the extent of drilling which is necessary in the different lesions observed at the CCJA.

### Patients and Methods

Over the period 1980–1995, we surgically treated 125 lesions in and around the CCJA using either the postero-lateral or the antero-lateral approach. These techniques have already been published and therefore are only briefly reported [3, 5–8].

The *postero-lateral approach* is the lateral extent of the midline posterior approach. The patient is usually in the sitting position, the incision is vertical in the midline up to the occipital protuberance and then curved laterally towards the mastoid process. The occipital bone and the posterior arch of atlas are exposed up to the mastoid process and the transverse foramen of atlas. The vertebral artery (VA) is firstly controlled in its groove on the posterior arch of atlas and then displaced superiorly or inferiorly to permit the bone drilling of the lateral mass of atlas or of the condyle respectively. This approach opens the posterior fossa and the first cervical level up to the lateral wall of the CCJA (jugular tubercle, condyle and lateral mass of atlas).

The *antero-lateral approach* is the upper extent of the approach used to control the VA in the neck. The patient is in a supine position. The incision is along the medial edge of the sterno-mastoid muscle and prolonged along the mastoid process. The sterno-mastoid muscle is detached from the mastoid process and the accessory nerve is exposed. Then, working in the plane between the internal jugular vein medially, and the sterno-mastoid muscle laterally, the VA is controlled from C2 to the foramen magnum. Occasionally the transverse foramina of C1 and C2 are unroofed to permit the



Fig. 1. Post-operative CT scanner (coronal view) showing a lateral grafting: iliac bone graft (arrow) impacted between the condyle and the superior facet of C2 after removal of an aneurysmal cyst destroying the lateral mass of atlas

transposition of the VA. This approach means the posterior and anterior part of the CCJA can be reached on one side.

Only the cases treated surgically with one of the lateral approaches were retained for analysis of the extent of drilling.

The observed lesions were classified following their location inside, into or outside the bone structures of the CCJ.

Appreciation of the extent of drilling was done during surgery by the surgeon and was then checked post-operatively by CT scanner. The extent of drilling was appreciated on axial views from the surface reduction of one of the two joints: C0–C1 (occipital condyle and lateral mass of atlas) and C1–C2. Three groups were defined. A: surface reduction of less than one third. B: reduction between one third and one half. C: reduction of more than one half.

In case of resection of more than one half of the surface of a joint, stabilization was achieved using one of the following two techniques:

- Posterior fixation with especially designed titanium plates (Access cervical posterior fixation. BIOMAT S.A. Domaine Technologique de Saclay 4 rue René Razel 91892 SACLAY (FRANCE)), screwed or fixed by hooks on the occipital bone and the first cervical vertebra, associated with bone grafting.
- Lateral grafting (3) with a tricortical bone graft harvested from the iliac bone, inserted and impacted between what remained of the occipital condyle and the superior facet of C2 (Fig. 1).

In the first technique of posterior fixation, the wearing of a soft collar for three weeks was sufficient, while in the second technique involving lateral grafting, the patient was asked to wear a rigid Philadelphia collar-type orthosis for two months.

## Results

The series includes 114 tumours and 11 non-tumoural processes (Tables 1 and 2).

Among the tumours, there were 14 chordomas and 23 bone tumours of different types. The non-tumoural processes (N = 11) are listed in table II. Therefore, non-osseous tumours represent 77 cases as opposed to 48 cases of bone tumours and lesions.

### Location

In the whole series, 38 lesions were anteriorly located and therefore extended beyond the anterior midline. Of the anterior lesions, 21 were non-osseous tumours, 9 were chordomas, 6 were bone tumours and 2 were

Table 1. *Tumours at the CCJA Treated by Lateral Approaches*

Meningioma	42
Neurinoma	24
Chordoma	14
Bone tumour	23
Miscellaneous	11

Table 2. *Non-Tumoural Processes at the CCJA Treated by Lateral Approaches*

Bone malformation	4
Synovial cyst	2
Rheumatoid arthritis	1
Spondylosis	2
Tuberculosis	1
Actinomycosis	1

Table 3. *Location in the Horizontal Plane*

	Anterior	Lateral	Posterior
Meningioma	19	23	–
Neurinoma	–	24	–
Chordoma	9	5	–
Bone tumour	6	16	1
Miscellaneous	2	4	5
Non-tumoural process	2	9	–

Table 4. *Non-Osseous Tumours Relation to the Bone Structures*

	Inside	Inside and outside
Meningioma	37	5
Neurinoma	15	9
Miscellaneous	8	3

non-tumoural processes (one synovial cyst and one inflammatory pannus). Eighty one lesions were lateral including 51 non-osseous tumours, 5 chordomas, 16 bone tumours and 9 non-tumoural processes. The six remaining cases were mostly posterior with more or less lateral extension (Table 3).

### *Relation to the Bone Structures of the CCJ (Tables 4 and 5)*

In the group of tumours, excluding chordomas and bone tumours, most of them were inside the bone limits of the CCJA. However 5 meningiomas, 9 neurinomas, 1 angiomyolipoma, 1 histocytofibroma and 1 fibroblastoma extended out of the bone limits of the CCJA.

Table 5. *Bone Tumours and Non-Tumoural Processes Relation to the Bone Structures*

	Into and inside	Into	Into and outside
Chordoma	–	–	14
Bone tumour	–	14	9
Non-tumoural process	3	6	2

Table 6. *Surgical Approaches*

	Postero-lateral	Antero-lateral
Meningioma	37	5
Neurinoma	15	9
Chordoma	–	14*
Bone tumour	4	19
Miscellaneous	7	4
Non-tumoural process	6	5

\* 4 bilateral approaches + 2 combined with trans-oral approach.

Fourteen bone tumours involved only the bone structures while all chordomas and 9 bone tumours also spread beyond them.

In the group of non-tumoural processes, all involved only the bone structures except three which were also located within the limits of the CCJA (the two synovial cysts and the rheumatoid arthritis) and two which extended outside the limits of the CCJA (the cases of actinomycosis and tuberculosis).

*Surgical Approach (Table 6)*

Surgery always implied one of the two lateral approaches. The postero-lateral approach was mostly used for non-osseous tumours (59 out of 77 cases) while the anterolateral approach was preferentially chosen for bone lesions (38 out of 48 cases). In 4 cases of chordomas, the antero-lateral approach was carried out on both sides, and in two cases, a transoral approach was associated with an anterolateral approach.

*Extent of Drilling (Tables 7–10)*

*Following the pathology.* According to the type of pathology, drilling was very limited (less than one third of the condyle and lateral mass of atlas) in all cases of non-osseous tumours (meningiomas, neurinomas, and miscellaneous types) (Fig. 2), whatever their extent inside and outside the limits of the CCJA (Table 7).

Table 7. *Extent of Drilling*

	<1/3	>1/3	>1/2
Meningioma	42	–	–
Neurinoma	24	–	–
Chordoma	–	5	9
Bone tumour	13	5	5
Miscellaneous	11	–	–
Non-tumoural process	9	2	–

Table 8. *Fixation Procedures*

	Posterior fixation	Lateral grafting
Chordoma	8	1
Bone tumour	1	4
Non-tumoural process	1	–

Table 9. *Extent of Drilling Relation to CCJA Bone Structures*

	<1/3	>1/3	>1/2
Inside	62	1	–
Inside + outside	17	–	–
Into	18	1	1
Into + outside	2	10	13

Table 10. *Extent of Drilling Location in the Horizontal Plane*

	<1/3	>1/3	>1/2
Anterior	21	6	11
Lateral	72	6	3
Posterior	6	–	–

In chordomas, the bony structures were always invaded and even, in 4 cases, on both sides of the CCJA (Fig. 3). Therefore, their removal required in every case, extensive resectioning (rather than drilling) of the bone structures. In 9 cases, bone resection was over half of the joint surfaces and between one third and one half in 5 cases.

In the group of bone tumours, drilling was over half of the joints surface in 5 cases (Table 7) (Fig. 4) between one third and one half in five other cases and less than one third in 13 cases.

In the non-tumoural processes group, two cases had a drilling between one third and one half and the other 9 cases a drilling of less than one third (Table 7) (Fig. 5).

*Following the location.* Considering the location of the lesion, drilling was limited to less than one third of the joint surfaces in all but one case located only inside

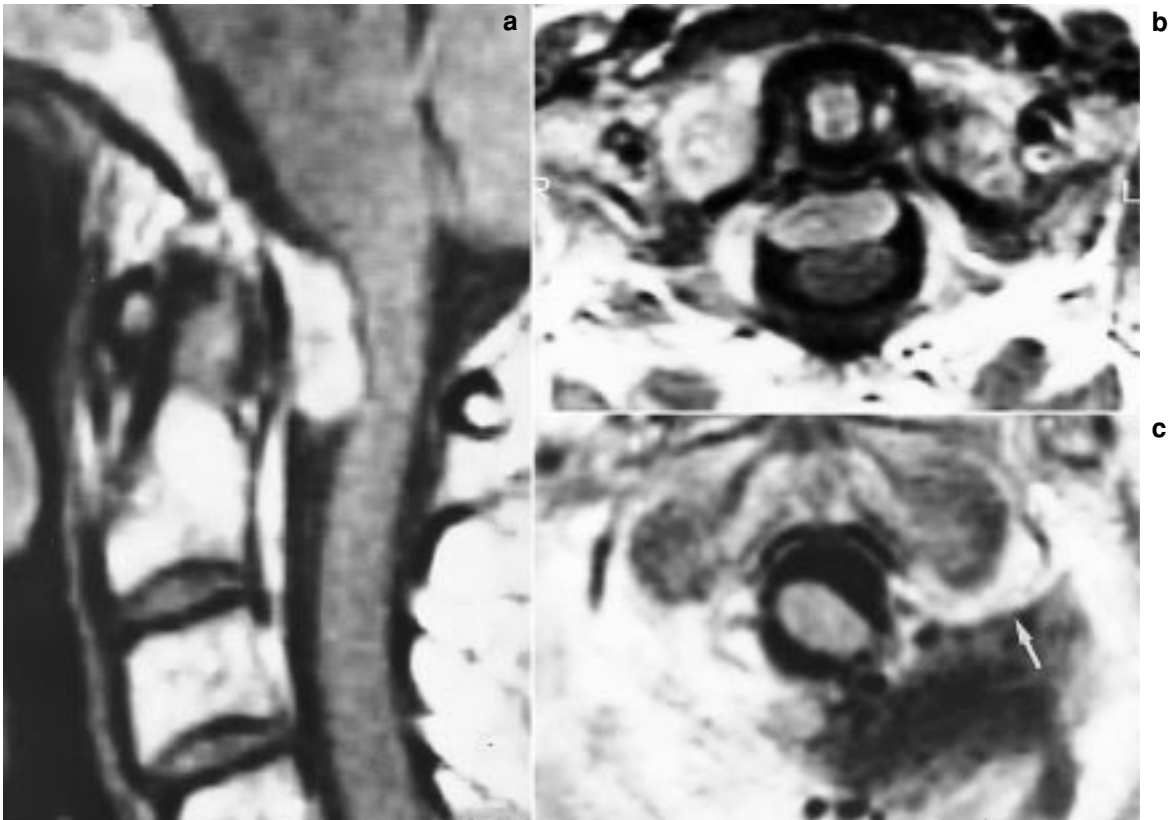


Fig. 2. Anterior meningeoma of the foramen magnum. (a) Pre-operative sagittal view. (b) Pre-operative axial view. (c) Post-operative MRI. The arrow indicates the vertebral artery running around the intact condyle

the limits of the CCJA (Table 9). Only the case of rheumatoid arthritis required drilling of more than one third (Fig. 6).

In lesions involving the bone structures of the CCJA without extension outside the CCJA limits, drilling was over one third but less than one half in 1 case of non tumoural process (spondylosis), and over one half in 1 case of bone tumour (aneurysmal cyst).

Among the lesions with extension out of the bone limits of the CCJA, drilling of more than one third was carried out only in those also involving the bone structures of the CCJA: all chordomas and 9 bone tumours; of these, 9 chordomas and 4 bone tumours were drilled more than one half of the joints surface (Table 9).

Tumours developed inside and outside the bone limits of the CCJA but not into the bone structures, were all resected with less than one third drilling (Tables 4 and 9).

Considering the location in the horizontal plane, drilling of more than one third was done in 17 cases

out of the 38 anteriorly located lesions and in 9 out of the 81 lateral lesions (Table 10). Excluding chordomas and tumours destroying the bone structures, a significant (more than one third) drilling was necessary in only 2 cases; one case of rheumatoid arthritis with a pseudo-tumour (pannus) anteriorly located and one case of spondylosis involving the C1–C2 joint. In none of the non-osseous tumours, even those located anteriorly, was a significant drilling found to be useful.

#### *Tumour Resection*

A complete gross tumoural resection was achieved in all but three cases; one case of meningeoma in a very poor neurological condition with tetraplegia and coma, who had a deliberate partial resection; one case of aneurysmal cyst with bilateral extension in whom a small piece of tumour was left on the opposite side to the surgical approach and kept under regular controls; and one case of fibrous dysplasia for whom only a decompression was carried out.

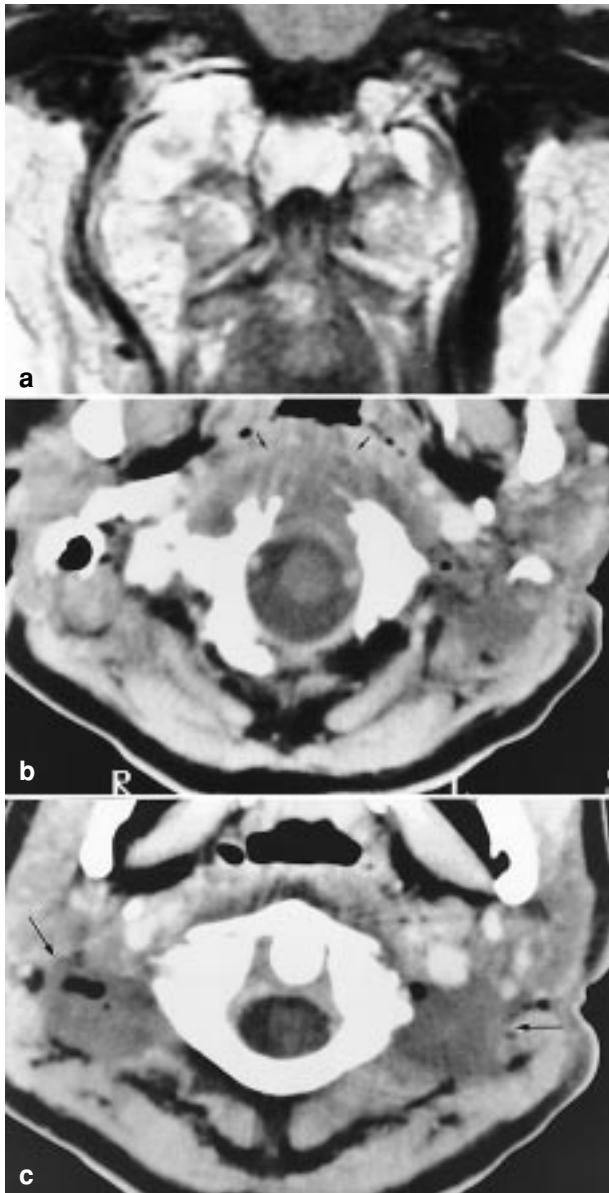


Fig. 3. Bilateral chordoma. (a) Pre-operative MRI (coronal view). (b and c) Post-operative CT scanner at the level of the condyle (b) and of the atlas (c). The arrows indicate the areas of resection

#### Fixation Procedure (Table 8)

A fixation was performed in 15 cases. Of them, 14 had a drilling of more than one half of the joint surfaces. The last case was a case of tuberculosis in whom the drilling was very limited but presenting pre-operatively a complete C0–C1 subluxation on one side. The cases having a drilling between one third and one half were just asked to wear a rigid collar for two months.

The stabilization was achieved by a posterior fixa-

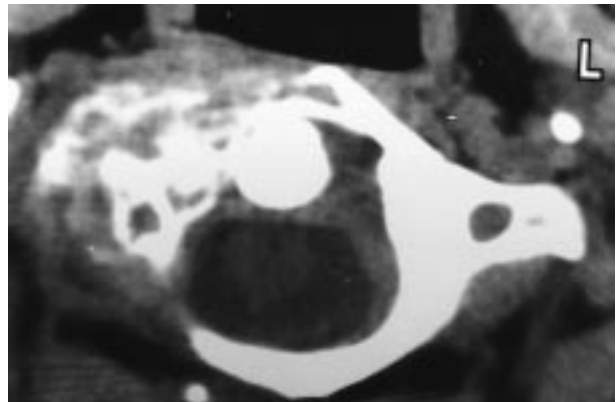


Fig. 4. Metastasis of a breast carcinoma involving the right lateral mass of atlas

tion in 10 cases including 8 chordomas, one bone tumour and the case of tuberculosis. A lateral grafting was performed for 1 case of chordoma and 4 cases of bone tumour.

No complication in relation to the stabilization procedure was observed in either the 10 cases with posterior fixation or the 5 cases with lateral grafting (Table 8). Fusion was obtained in every case. The functional result was always complete suppression of any possibility of rotation after posterior fixation; however, although after lateral grafting, rotation was limited, it was not completely abolished. The five cases have kept some 10 to 20 degrees of rotation towards the opposite side.

#### Discussion

With increasing interest in, and use of the lateral approaches to deal with CCJA lesions, confusion has appeared in the literature. In many reports, the term trans-condylar is used suggesting a more or less extensive drilling of the bony structures laterally limiting the CCJA [1, 2]. These bony structures include from the upper to the lower part of the CCJA, i-e the jugular tubercle, the occipital condyle, the lateral mass of atlas and therefore the first two cervical spinal joints (C0–C1 and C1–C2).

In fact, the CCJA can be approached from every side. On the anterior side, it is the trans-oral approach; on the posterior side, the midline posterior approach and on the lateral side one of the two lateral approaches, the postero-lateral and the antero-lateral approaches being the main axis of work. Sometimes a combination of two or even three approaches may be used which is what we did in 13 cases (7 antero-lateral

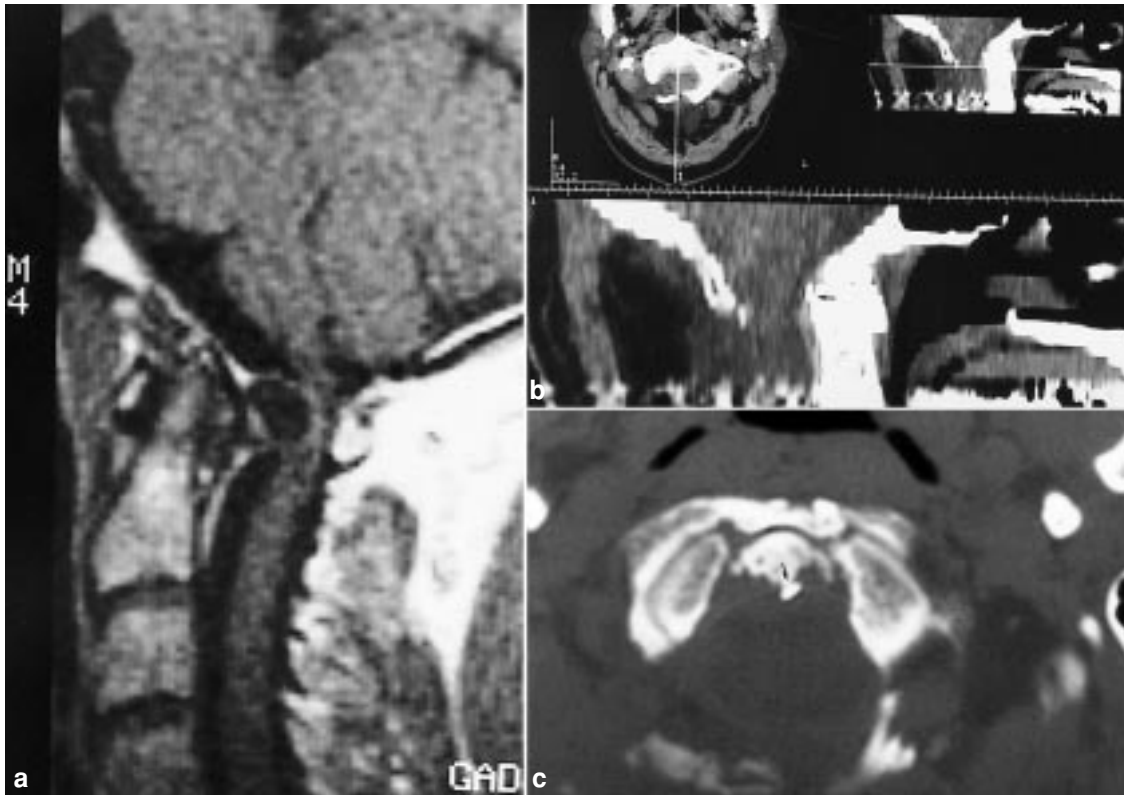


Fig. 5. Synovial cyst. (a) Pre-operative MRI (sagittal view). (b) Post-operative CT scanner showing the very limited drilling of the condyle. Notice the clip (arrow) placed on the tip of odontoid for post-operative checking. (c) Post-operative CT scan in coronal view. Notice the clip (arrow)

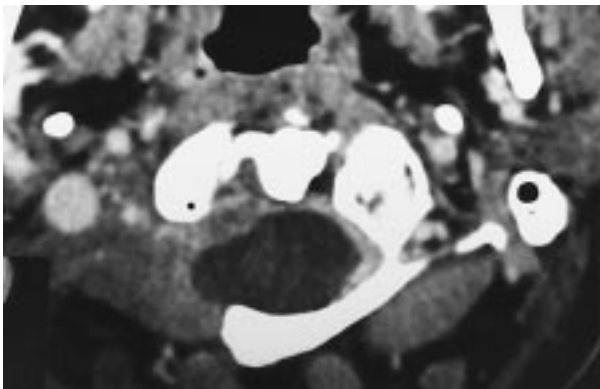


Fig. 6. Post-operative CT scan in a case of rheumatoid arthritis. Notice the significant drilling on the right side (asterisk)

and midline posterior approaches, 4 bilateral antero-lateral approaches and 2 antero-lateral and transoral approaches).

All these approaches should be familiar to anyone contemplating the surgical treatment of a CCJA lesion so as to be able to choose the most appropriate and the least destructive one. As a rule, surgical invasiveness

is only justified when a better result is expected and especially in terms of complete resection. The invasiveness in surgery at the CCJA is essentially related to bone resection and instability which may result. From the series reported here, significant resection of the bone structures of the CCJA was never necessary in the case of tumours unless they were already invaded and/or destroyed by the tumoural process. This means that extensive bone resection was only carried out in case of bone tumours whether they were benign or malignant, but with a large encroachment into the bone structures; all the chordomas were drilled more than one third and 9 of them more than one half; similarly, 5 of the 23 bone tumours were drilled more than one third and 5 others more than one half. Most of the cases which were significantly drilled, harboured a tumoural extension into and outside the bone structures of the CCJ. In none of the other cases of tumours and especially in meningiomas was significant drilling necessary. In spite of very limited drilling, the rate of complete resection was 98% whatever the anterior or lateral location. Only one case of meningioma had a

partial resection, not for technical reasons but because of a desperate neurological condition.

In the case of non tumoural processes which may be malformative, degenerative, inflammatory or infectious [1, 4], only 2 out of 11 cases needed a significant drilling but this was less than one half of the joints. In fact, one was a spondylotic lesion involving the C1–C2 joint in whom the drilling corresponded to the lesion resection. The other was an anterior pseudotumour due to rheumatoid arthritis which allowed the lesion to be reached. Therefore, this case is the only one who required a significant drilling of normal bone structures to obtain access.

By adequately choosing the surgical approach, significant drilling of the bone structures of the CCJA was almost never necessary or useful to reach, to expose and to resect a tumoural or a non-tumoural process at this level. The bony structures were only drilled out when the lesion already involved them. In other words, their drilling corresponded to the tumour removal. If a bone tumour or a lesion had a limited involvement in the bone structures, it was always possible to resect it without adding a significant resection of the normal bone structures.

As a result of the bone resection, instability may occur. In fact, since it is almost always unnecessary to add any supplementary bone removal to the destruction already produced by the tumour, the instability is to be considered pre-operatively from the tumoural bone invasion and not post-operatively from the surgical approach. In our series, we found that destruction of more than one half of the surface of the joints C0–C1 and/or C1–C2 was necessary to produce instability. The cases in whom a more limited drilling was carried out, had no surgical fixation.

In a few cases, the surgical fixation was delayed from two weeks to 3 months after tumour removal because of technical or social and financial problems. During the waiting period, these patients wore a rigid collar and did not experience any problems of stability. The longest period was 3 months in one case of chordoma where the entire joints were removed. Therefore, the need for a fixation procedure is questionable. However, it seems a safe attitude especially considering the possibility of falls or traffic accidents.

The modality of fixation is a matter for discussion since two main techniques can be applied: posterior osteosynthesis with bone grafting and lateral bone grafting. In our series, the former was done in 10 cases and the latter in 5 cases. Both techniques gave excellent

results in terms of fixation. The advantage of the posterior fixation is to provide an immediate stability and thus requires the shortest period with a rigid collar. The benefit of lateral grafting [3] is to be done at the same surgical stage and to keep some few possibilities of rotation. However, lateral grafting can only be applied when there is a sufficient remaining piece of bone on both sides of the tumour resection. It is always the case at the lower part (C1–C2 level), but not at the upper if the drilling has included the entire condyle and the jugular tubercle. A technique providing better restoration of function of the C0–C1 and C1–C2 joints is still to be developed.

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### Comments

The authors are demonstrating and emphasizing that in the approach to the craniovertebral junction one should drill the condyle as needed. They have demonstrated that many lesions will not require extensive drilling. However, the tone of the article and the conclusion might wrongly imply that no drilling should be done; hence, undermining the essence and the contribution of the transcondylar approach for the management of lesions at the craniovertebral junction.

Although a 1/3 of condyle drilling for intradural tumours such as meningiomas and schwannomas, as the authors found, is adequate in most of these cases it is also extremely advantageous. Their conclusion should not be a deterrent from additional drilling if it is needed to reach a more ventrally located meningioma. The more lateral exposure to reach ventrally located meningiomas might allow less morbidity particularly in terms of less trauma to the lower cranial nerves and the medulla; hence, the advantage will be apparent by lessening the morbidity and not in the ability of total removal. This is an issue that has not been addressed by the authors.

As they have found, the arbitrary decision to fuse when half of the condyle is drilled might not be necessary. Overall stability and the nature of the lesion treated may be more important in this regard.

*O. Al-Mefty*

The authors report on a large series of 125 lesions of the cranio-cervical junction which have been treated over a 16-year period in the same Institution. The aim of this report is to define the amount of bone resection (joints surface) necessary to treat these lesions. The authors conclude that in the large majority of the patients only less than one-third of the joint surfaces were resected to successfully treat the lesions. In 14 cases only, more than one half of the joints had to be removed. Of these, in 13 cases the joints were already invaded by the tumour. This is an excellent, straight-forward and well written paper with a direct message to the reader. The authors' message is an up-to-date one, and we fully agree with it. In the present era of skull base surgery, in which many surgeons are performing unnecessary bone resection to treat lesions of the cranio-cervical junction, the present paper is of extreme importance. The authors are commended for the results they achieved in these cases.

*M. Samii*  
*M. Tatagiba*

Correspondence: B. George, M.D., Service de Neuro-Chirurgie, Hôpital Lariboisière, 2 rue Ambroise Pare, 75010 Paris France.